

AD-A233 062

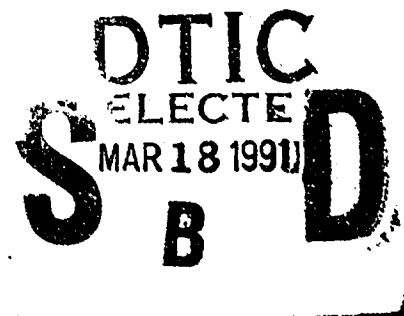
2

December 1990

M90-93

M. M. Weiner

Electrically-Small,
Quarter-Wave, and
Resonant Monopole
Elements with Disk
Ground Planes in
Free Space



Approved for public release;
distribution unlimited.

MITRE

Bedford, Massachusetts

91 3 12 141

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188), Washington, DC 20503.

1. AGENCY USE ONLY (Leave blank)		2. REPORT DATE 12/90		3. REPORT TYPE AND DATES COVERED FINAL	
4. TITLE AND SUBTITLE ELECTRICALLY-SMALL, QUATER WAVE, AND RESONANT MONOPOLE ELEMENTS WITH DISK GROUND PLANES IN FREE SPACE				5. FUNDING NUMBERS PR = 91260	
6. AUTHOR(S) M. M. WEINER					
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) The MITRE Corporation Burlington Road Bedford MA				8. PERFORMING ORGANIZATION REPORT NUMBER M90-93	
9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES) The MITRE Corporation Burlington Road Bedford, MA				10. SPONSORING / MONITORING AGENCY REPORT NUMBER N/A	
11. SUPPLEMENTARY NOTES N/A					
12a. DISTRIBUTION / AVAILABILITY STATEMENT Approved for public release; distribution unlimited.				12b. DISTRIBUTION CODE	
13. ABSTRACT (Maximum 200 words) This paper extends previously reported results for a quarterwave monopole element on a disk ground plane in free space to include electrically-small and resonant elements. Numerical results are obtained by utilizing Richmond's method-of-moments computer program for disk ground planes in free space.					
14. SUBJECT TERMS Gain-Monopole Elements				15. NUMBER OF PAGES 13	
				16. PRICE CODE	
17. SECURITY CLASSIFICATION OF REPORT Unclassified	18. SECURITY CLASSIFICATION OF THIS PAGE Unclassified	19. SECURITY CLASSIFICATION OF ABSTRACT Unclassified	20. LIMITATION OF ABSTRACT UL		

December 1990

M₉₀₋₉₃

M. M. Weiner

**Electrically-Small,
Quarter-Wave, and
Resonant Monopole
Elements with Disk
Ground Planes in
Free Space**

CONTRACT SPONSOR MSR
CONTRACT NO. N/A
PROJECT NO. 91260
DEPT. D085

Approved for public release;
distribution unlimited.

MITRE

**The MITRE Corporation
Bedford, Massachusetts**

ABSTRACT

This paper extends previously reported results for a quarterwave monopole element on a disk ground plane in free space to include electrically-small and resonant elements. Numerical results are obtained by utilizing Richmond's method-of-moments computer program for disk ground planes in free space.

Accession For	
NTIS GRA&I	<input checked="checked" type="checkbox"/>
DTIC TAB	<input type="checkbox"/>
Unannounced	<input type="checkbox"/>
Justification	
By	
Distribution/	
Availability Codes	
Dist	Avail and/or Special
A-1	



TABLE OF CONTENTS

SECTION	PAGE
Electrically-Small, Quarter-Wave, and Resonant Monopole Elements with Disk Ground Plane in Free Space	1
Acknowledgments	2
List of References	2

LIST OF FIGURES

FIGURE	PAGE
1 Antenna Geometry	3
2 Directive Gain Patterns	4
3 Radiation Resistance	5
4 Directive Gain on the Horizon	6
5 Peak Directivity	7
6 Elevation Angle of Peak Directivity	8
7 Input Resistance	9
8 First-Order Resonance	10
9 Input Impedance, $2\pi a/\lambda = 0.25$	11
10 Input Impedance, $2\pi a/\lambda = 0.025$	12
11 Input Impedance, $2\pi a/\lambda = 0$	13

ELECTRICALLY-SMALL, QUARTER-WAVE, AND RESONANT MONOPOLE ELEMENTS WITH DISK GROUND PLANES IN FREE SPACE

This paper extends previously reported results [1], [2] for quarter-wave elements on disk ground planes in free space, to include electrically-small and resonant elements. Numerical results are obtained by utilizing Richmond's method-of-moments for disk ground planes in free space [3].

The geometry is characterized by only three parameters when the parameters are normalized to the rf wavelength λ : element length h/λ , element radius b/λ , and disk radius $2\pi a/\lambda$ (see figure 1). The current on the outside of the coaxial-line feed is assumed to be zero because of attenuation by lossy ferrite toroids along the exterior of the coaxial line feed [4].

The directive gain pattern, radiation resistance, directive gain on the horizon, peak directivity, and elevation angle of peak directivity for electrically-small elements are similar to those for quarter-wave elements (see figures 2-6). The input reactances, for electrically-small and quarter-wave elements much larger than the disk radius, are negative and positive, respectively, and are approximately independent of disk radius (see figure 7).

The element lengths for first-order resonance, first-order anti-resonance, second-order resonance, and second-order anti-resonance vary by as much as 30% from the values of 0.25, 0.5, 0.75, and 1.0 wavelengths, respectively, for disk radii greater than 0.25 wavenumbers (see figures 8 and 9). Anti-resonances (but not resonances) occur for disk radii less than approximately 0.025 wavenumbers (see figures 10 and 11).

ACKNOWLEDGMENT

L. W. Parker and C. R. Sharpe performed the computer runs and developed the computer plots.

REFERENCES

1. M. M. Weiner, "Monopole Element at the Center of a Circular Ground Plane of Arbitrary Radius," Proceedings, PIERS 1990, July 25-26, 1990, Boston, MA, p. 216.
2. M. M. Weiner, "Monopole Element at the Center of a Circular Ground Plane Whose Radius is Small or Comparable to a Wavelength," *IEEE Trans. Ant. and Prop.*, Vol. AP-35, No. 5, May 1987, pp. 488-495.
3. M. M. Weiner, S. P. Cruze, C. C. Li, and W. J. Wilson, *Monopole Elements on Circular Ground Planes*, Norwood, MA: Artech House, 1987, pp. 45-47, 78-85.
4. op. cit. 3, pp. 12-17.

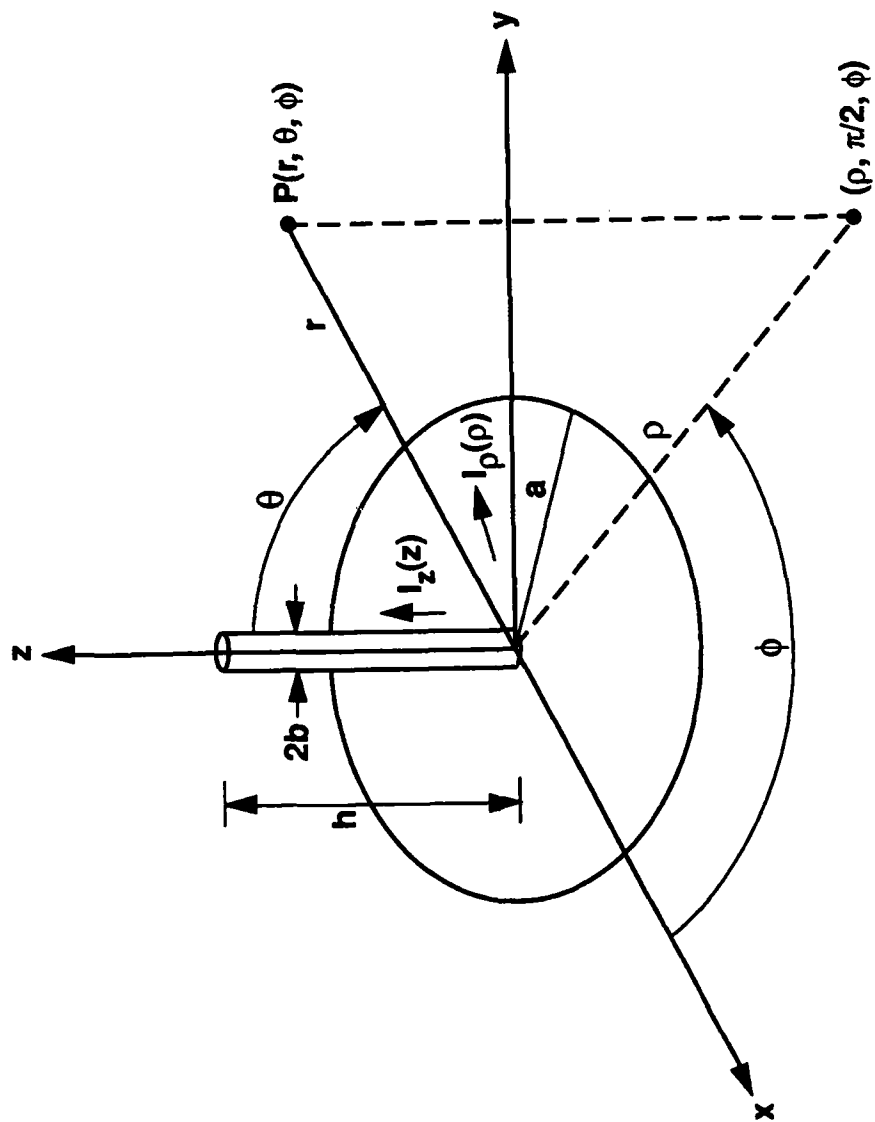


Figure 1. Antenna Geometry

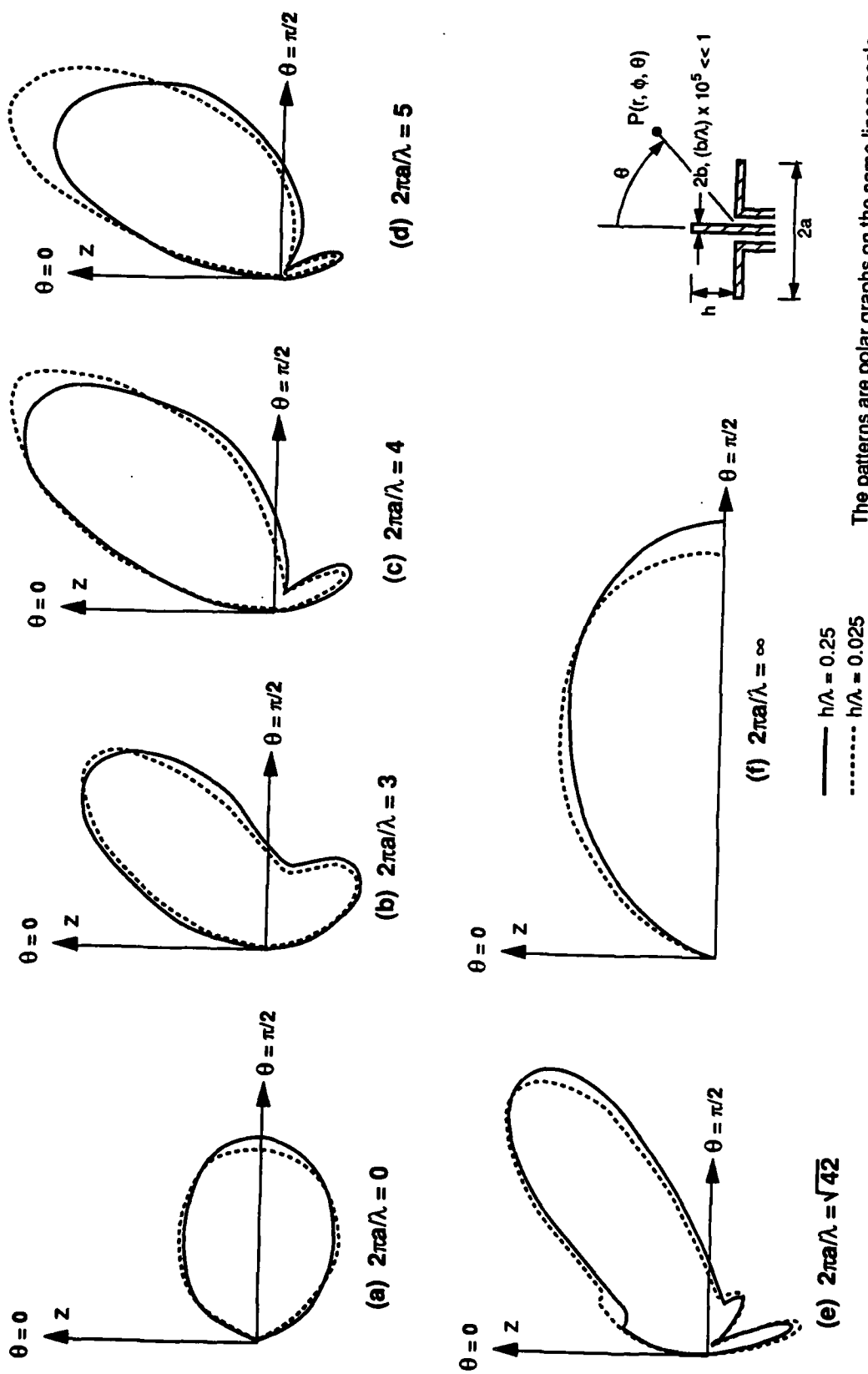


Figure 2. Directive Gain Patterns

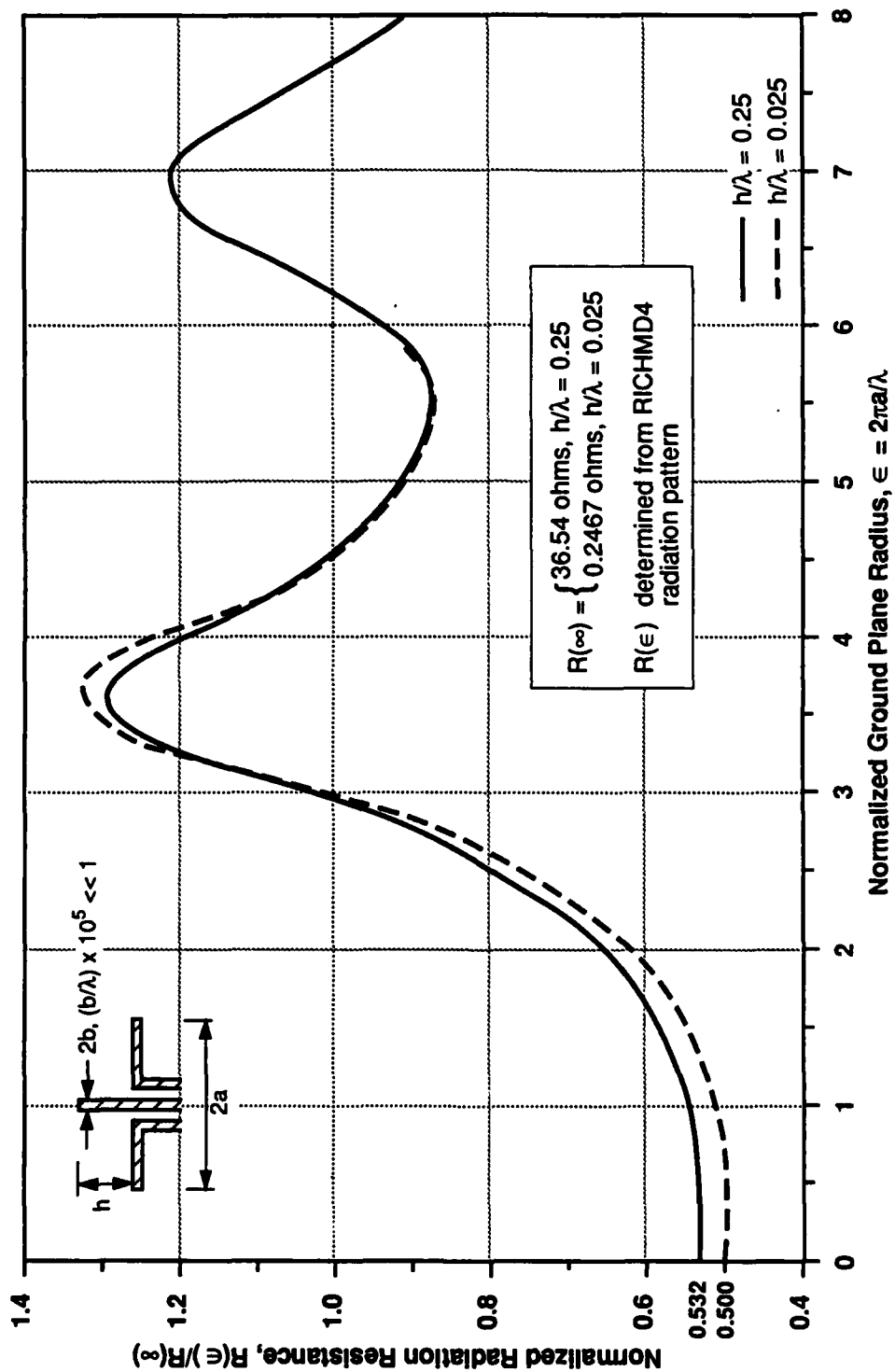


Figure 3. Radiation Resistance

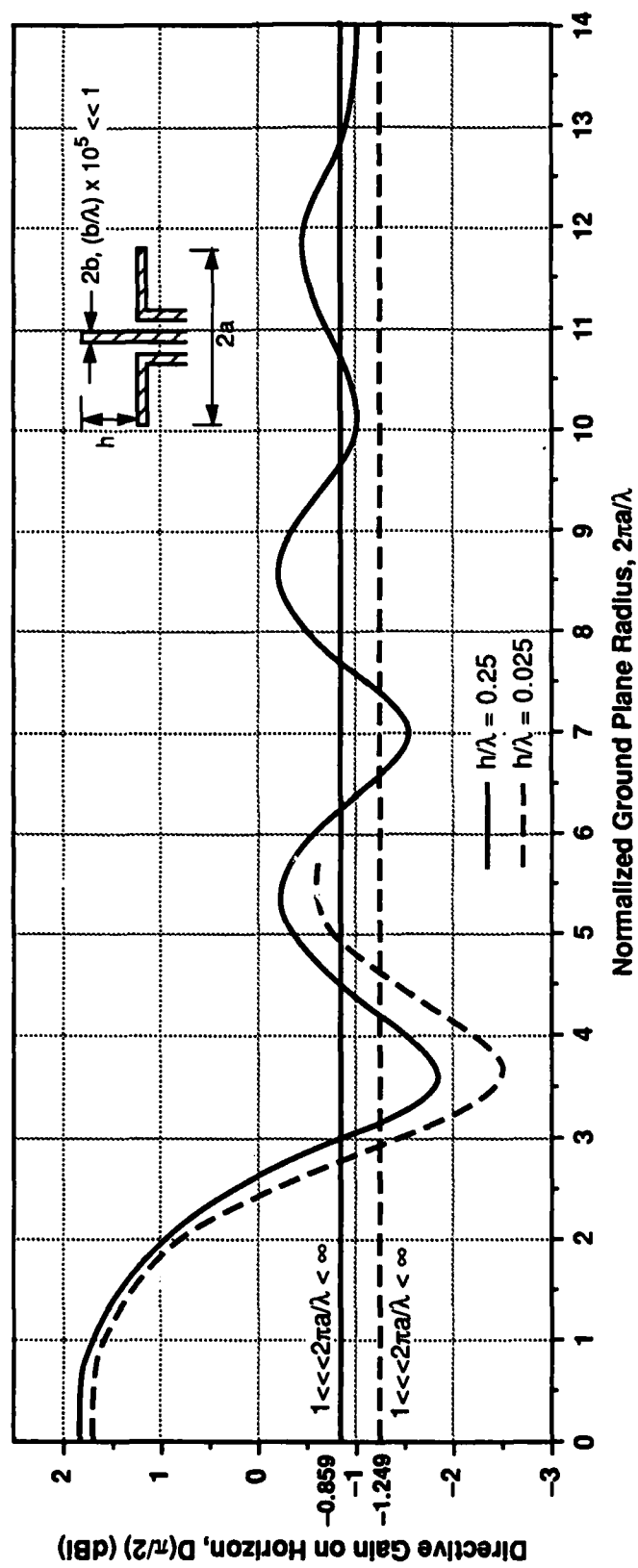


Figure 4. Directive Gain on the Horizon

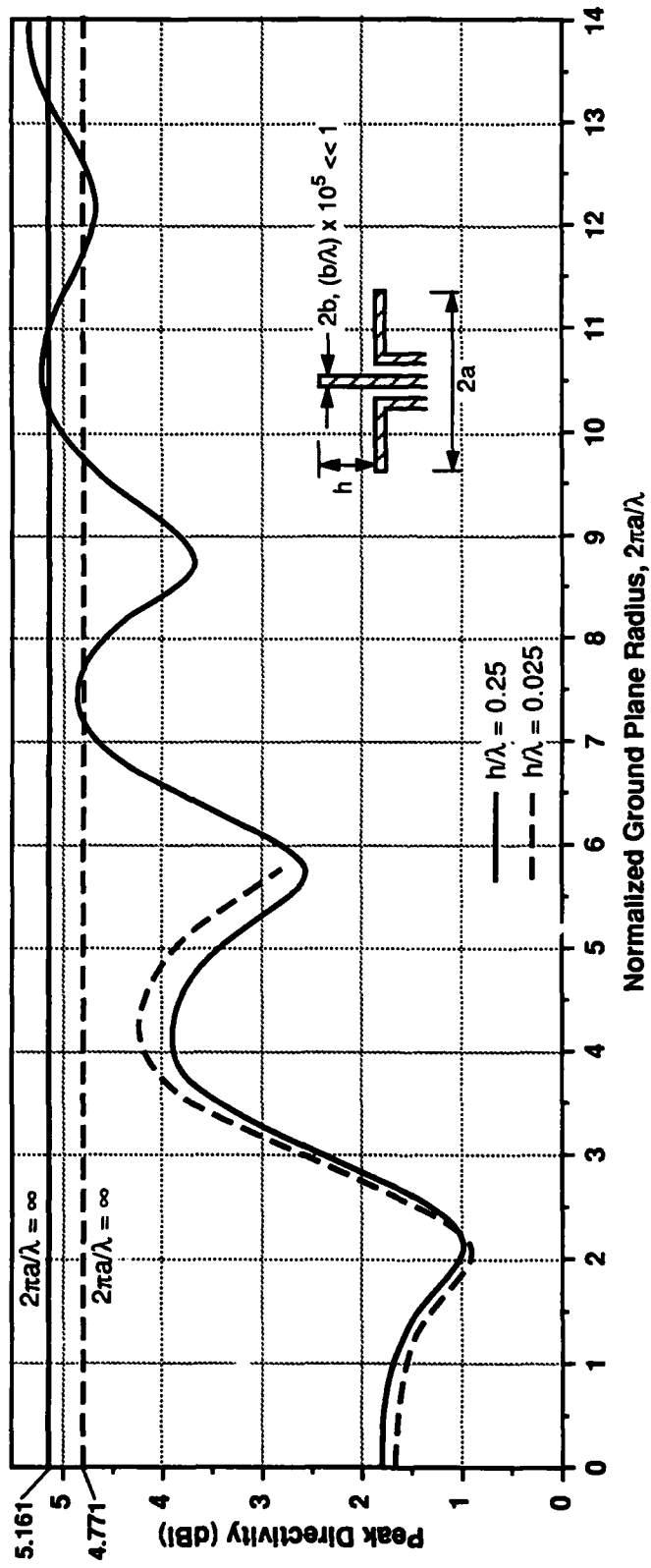


Figure 5. Peak Directivity

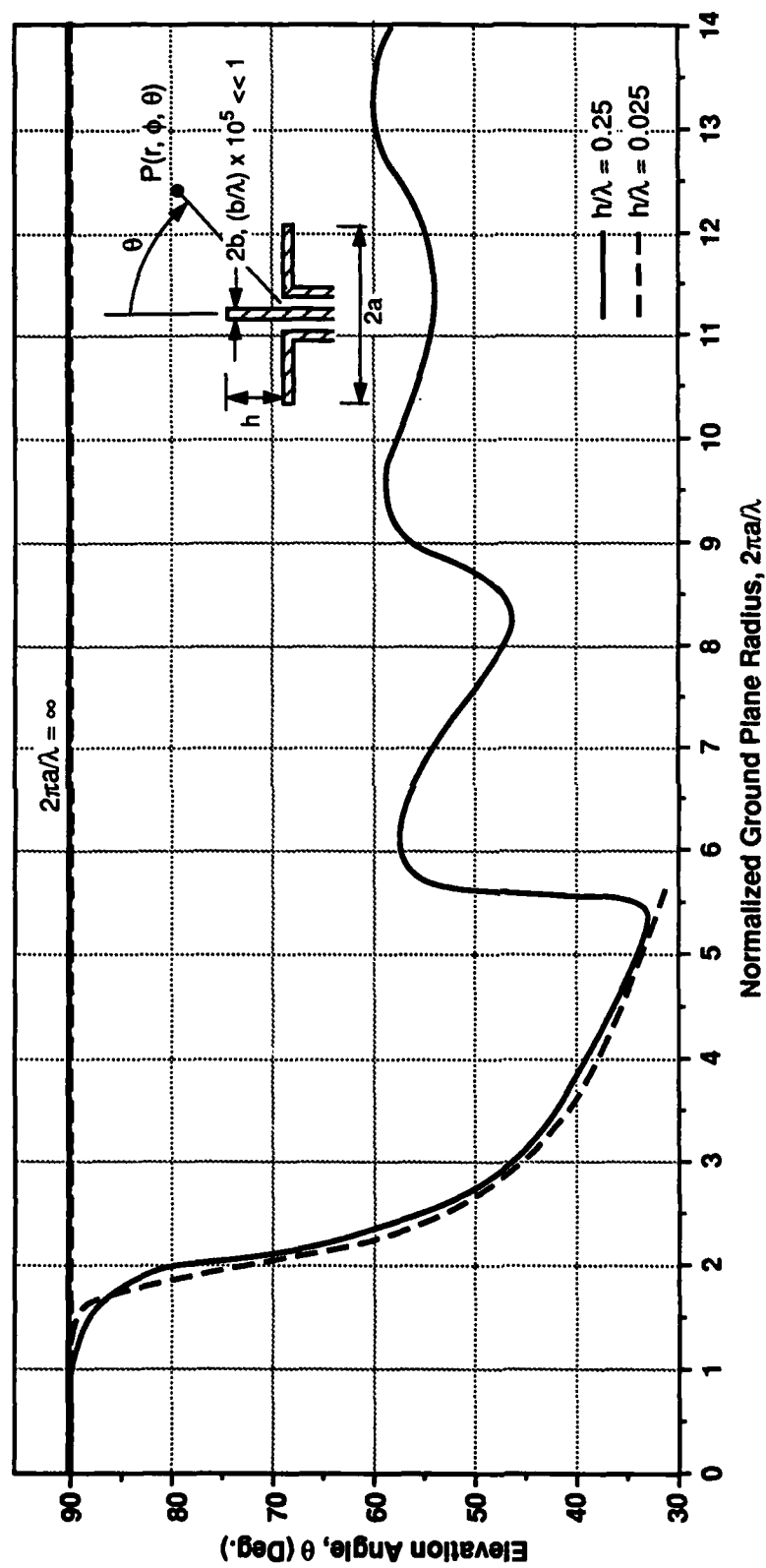


Figure 6. Elevation Angle of Peak Directivity

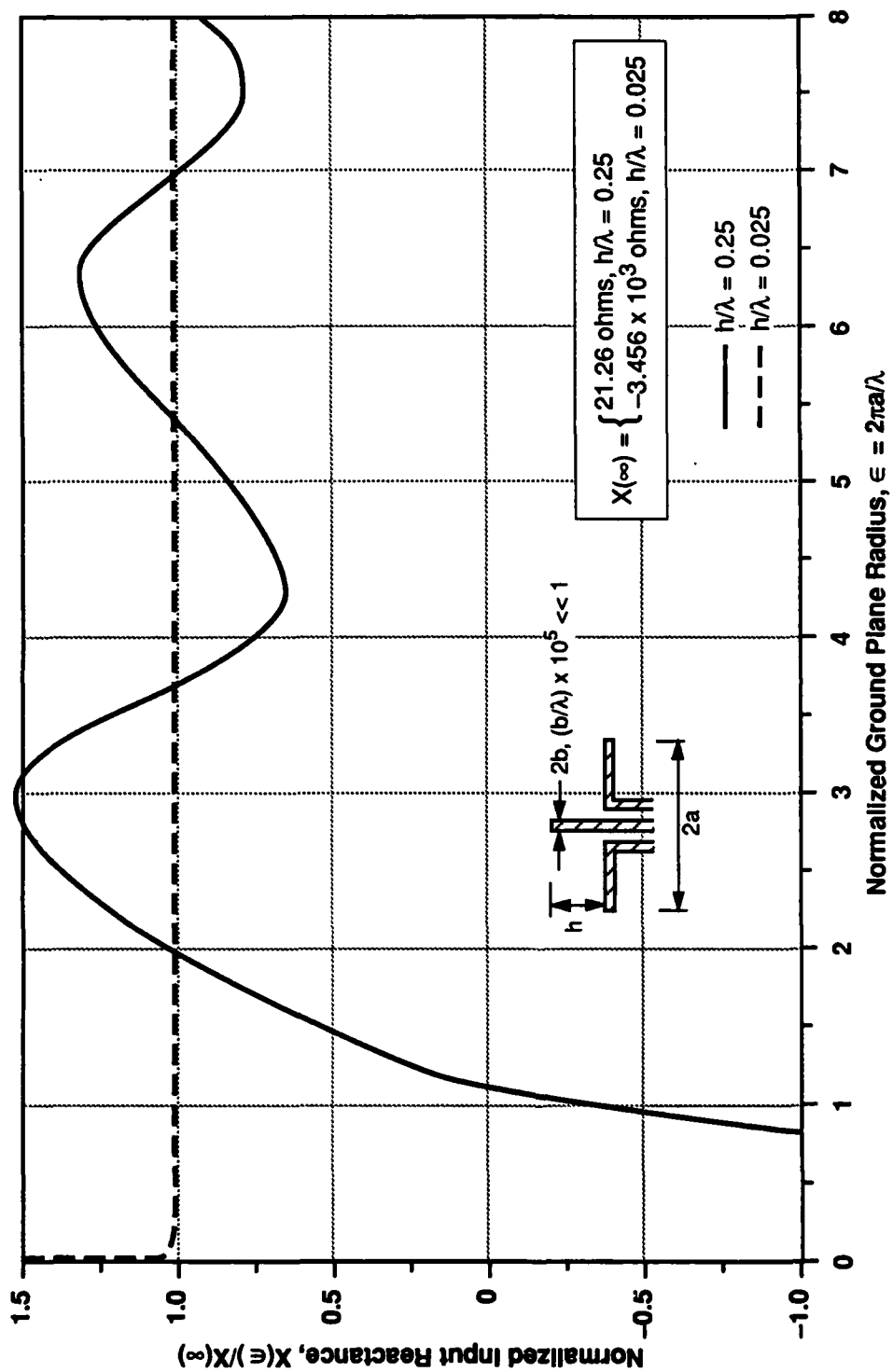


Figure 7. Input Reactance

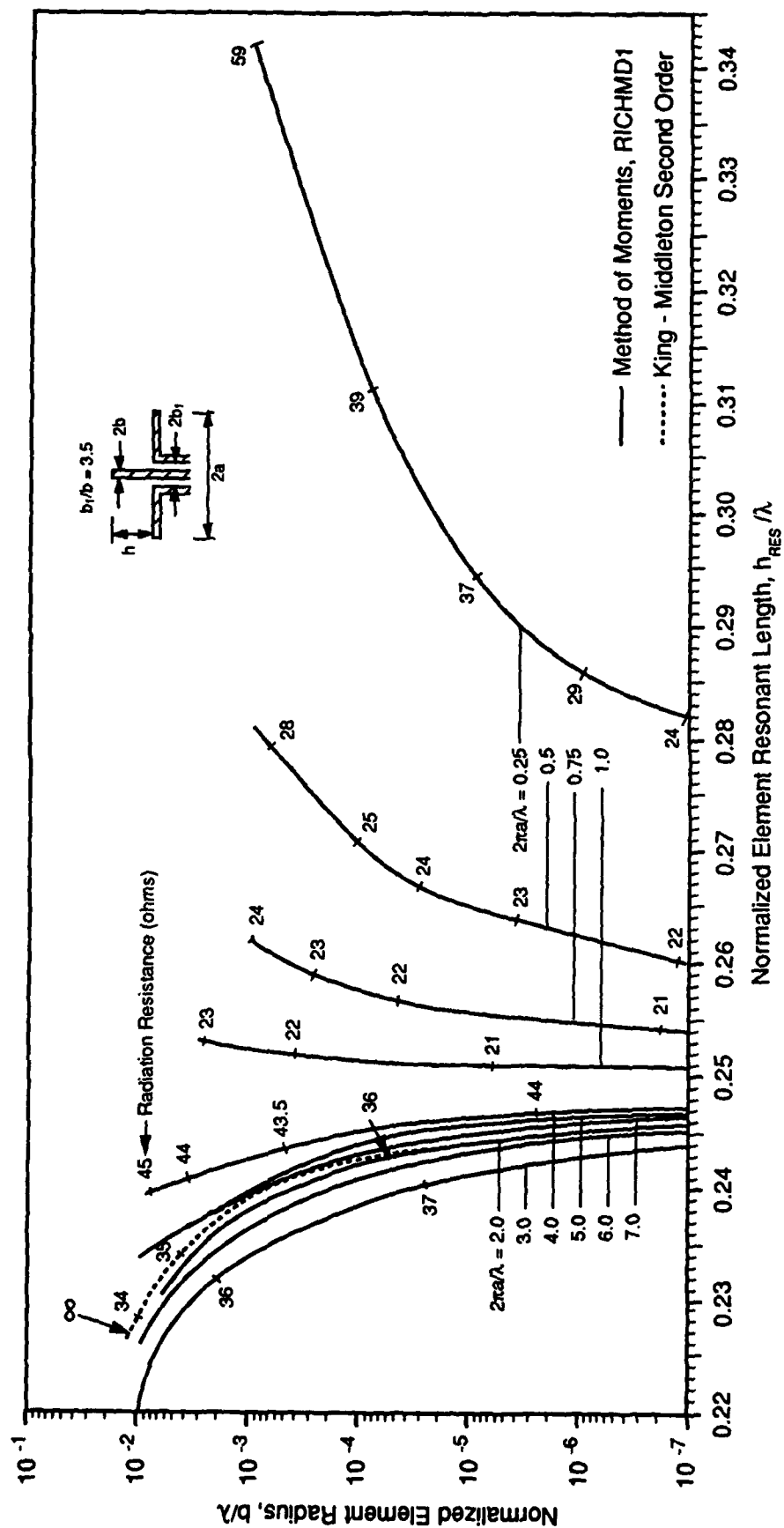


Figure 8. First-Order Resonance

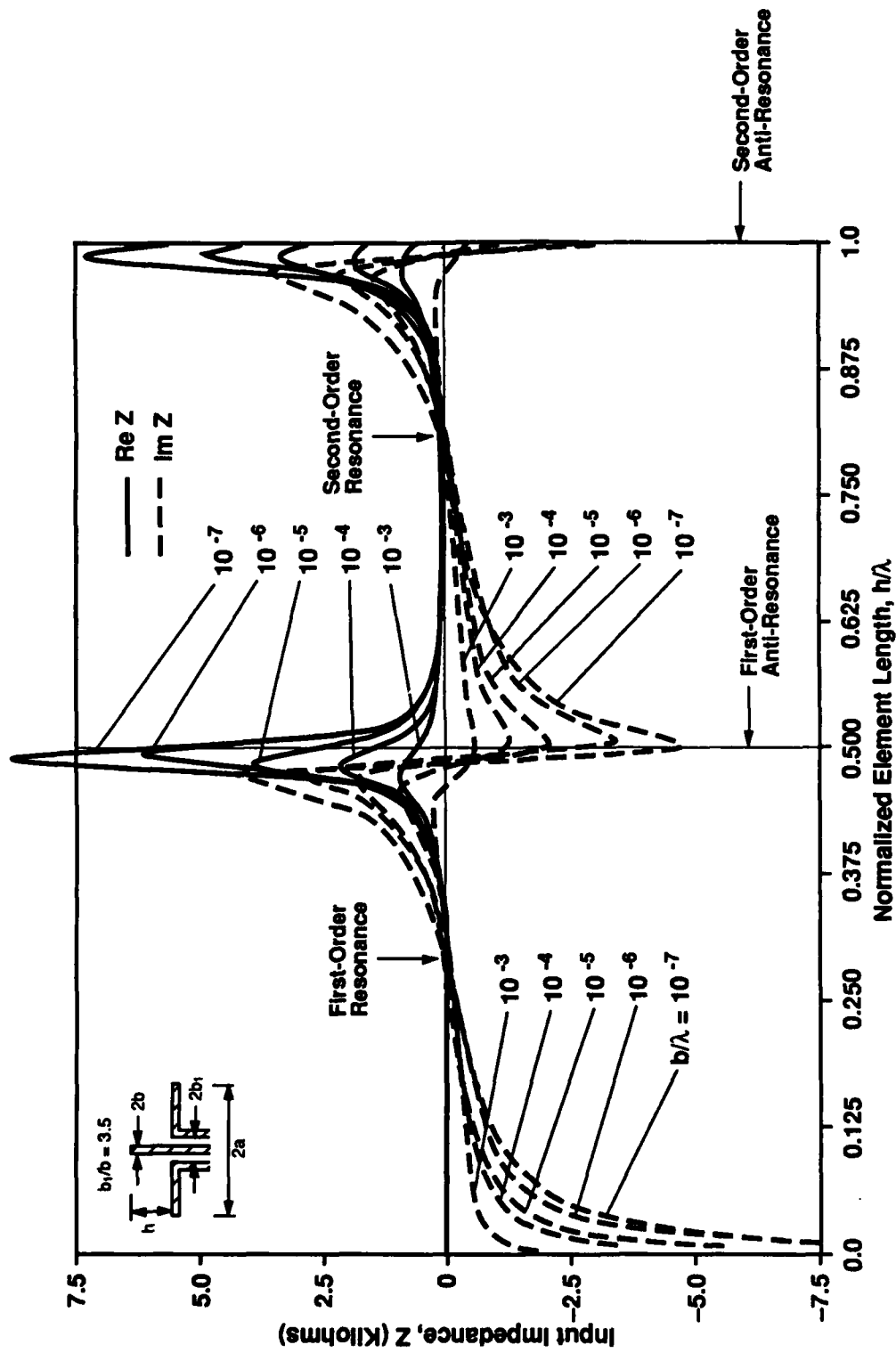


Figure 9. Input Impedance, $2\pi a/\lambda = 0.25$

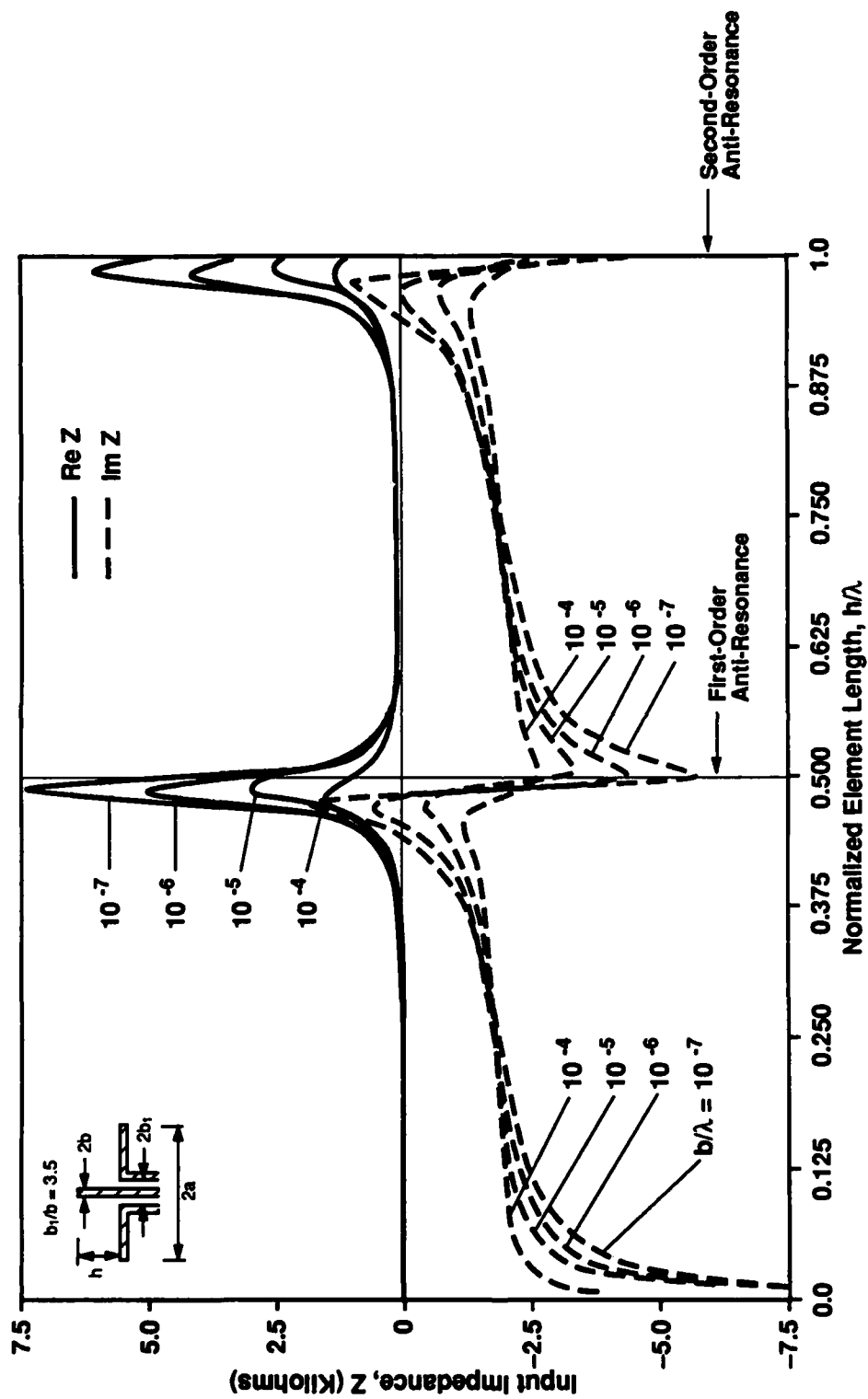


Figure 10. Input Impedance, $2\pi a/\lambda = 0.025$

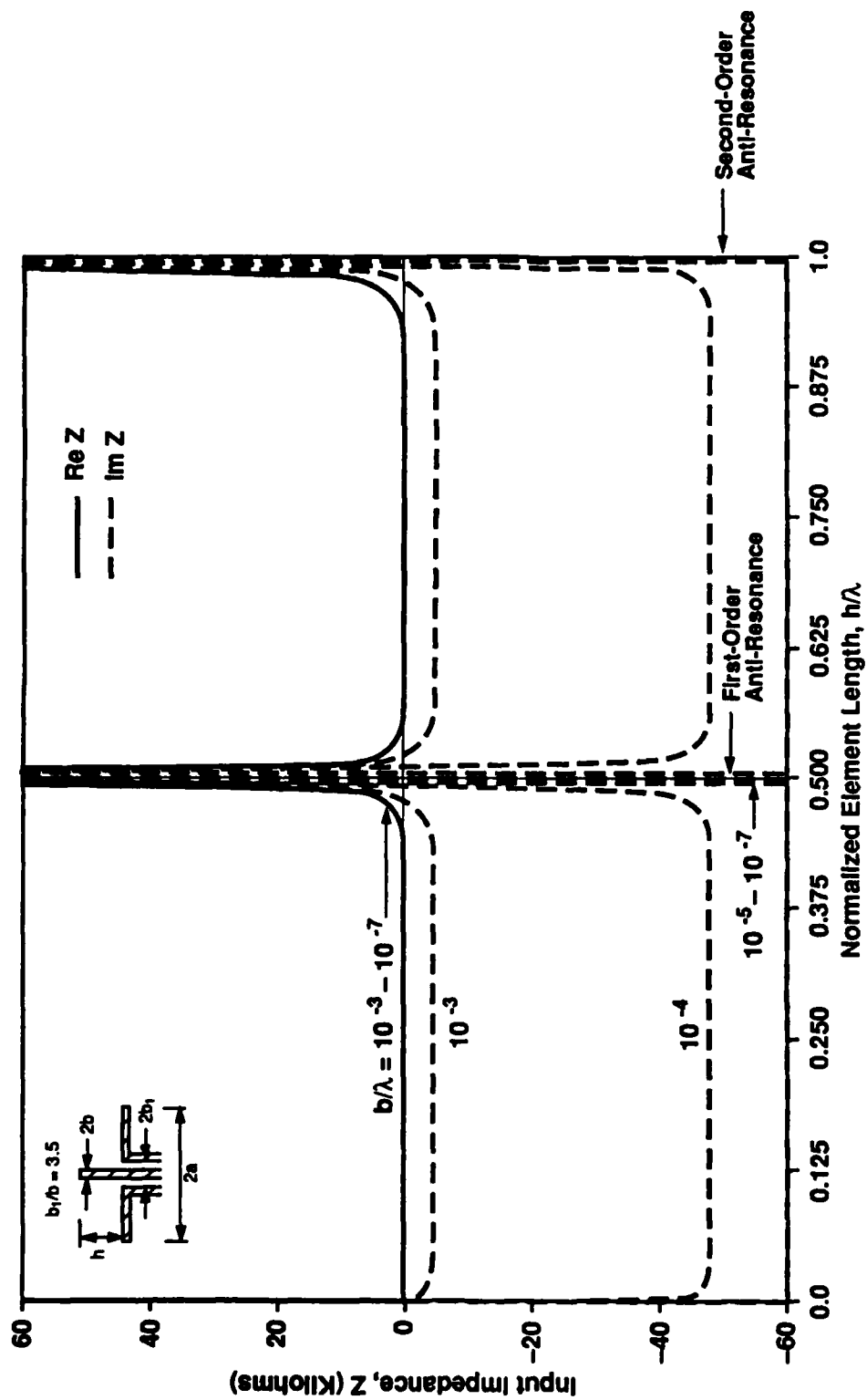


Figure 11. Input Impedance, $2\pi a/\lambda = 0$